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with the moth Abraxas. It is hoped Professor Wilson may be able to make cytological studies on some of these cases.

The fact that such characters as eye color in canaries, barring in poultry, and melanic types in Abraxas may be coupled with sex points strongly to the chromosomic nature of these characters. The work of Professor R. R. Gates, and that of Miss Annie E. Lutz on the chromosomes of Œnothera points strongly to the assumption that chromosomes are the elements with which we have to deal in the study of hereditary characters. Their results indicate that mutations of the De Vriesian type are due to accidents in mitosis. Miss Lutz remarks:[5]

> The numbers of chromosomes are closely associated with external characters in the first and last, and probably also in the second group.

Professor Gates has also expressed the opinion that abnormal chromosome behavior may account for the mutation phenomena observed by De Vries. It seems probable, therefore, that mutations of this character do not represent what we may call normal evolutionary changes, but that the latter must be sought in changes in the chemical constitution of the chromosomes.

W. J. SPILLMAN.

ENVIRONMENT

The Effect of Environment upon Animals.—"Katy-did, Katy-didn't" seems to continue to be a fair summary of the situation with respect to the heredity of acquired characters and the part played by environment in evolution. Wallace wrote in the *Fortnightly Review* (January, 1908) restating his belief in natural selection and recommending a careful study of Reid's "The Principles of Heredity" and Ball's "Are the Effects of Use and Disuse Inherited?" Rev. Henslow followed his advice and has published a short, suggestive and very readable book[1] on "The Heredity of Acquired Characters in Plants," in which he states with even more assurance than before the conclusion of his "Origin of Plant Structures," that "the Origin of Species is due to the joint action alone of the two great factors of evolution—*Variability* and *Environment*—without the aid of natural selection." This additional assurance seems to be the result of the growth of the ecological school of botanists and his belief that ecologists are "all at one" in accepting the fact that evolution in plants is the result of the effects of the environment which *can* become heredity.

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[5] *Science*, February 12, 1909.

[1] London, John Murray, 1908, 107 pp.

> In 1876 Darwin had become a true ecologist. In this year he wrote to Professor Moritz Wagner as follows: "The greatest mistake I made was, I now think, I did not attach sufficient weight to the direct influence of food, climate, etc., quite independently of natural selection. When I wrote my book and for some years later, I could not find a good proof of the direct action [*i. e.,* in producing definite variations] of the environment on the species. Such proofs are now plentiful [Henslow says 'universal']."
>
> Plant ecologists . . . are accepting "Adaptation" by response as a *proved fact.* . . . A complete change of front has taken place within the last twenty years, but as Darwin himself was the first [?] to propound this view, I called it "The True Darwinism."

Zoologists have been rather behind the botanists in ecological work, but the zoological school of ecology is growing and it does seem true that the more organisms are studied with regard to their relations to their environment, "at home," the stronger becomes the belief in the importance of environment in evolution. Whether this is "True Darwinism" or something else is immaterial, only so it be true.

The most serious difficulty has been to get a good way of accounting for the inheritance of characters produced by the environment. Cunningham[2] seems now convinced that this difficulty is removed by "hormones," or internal secretions, retracting his former idea that the nexus between secondary sexual characters and the gonads is nervous. Starling's proof that the growth of mammary glands in an unimpregnated rabbit is caused by injection of extracts of fœtuses from pregnant rabbits is given as an illustration of the working of hormones. Applied to the development in phylogeny of horns, for example, it is supposed to work about as follows:

> Since the development of the somatic sex-characters is due to the stimulation of the cells by a hormone derived from the gonad, it is conceivable that the gametes may be affected by the internal secretion of the somatic cells whose development constitutes the sex-character. It is quite possible that the hormone in the case of the gonad, perhaps in all cases, is merely the waste product of metabolism occurring in the cell-multiplication. Whether this is so or not, the somatic sexual structure, such as the antler, would naturally excrete into the blood special substances, and these being in the blood the gametes would be multiplied and developed under their influence. We can not suppose that all cells or parts of the body produce living gemmules which are collected in the germ-cells, but we have reason to conclude that all

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[2] "The Heredity of Secondary Sexual Characters in Relation to Hormones, a Theory of the Heredity of Somatogenic Characters." *Archiv Entwicklungsmechanik,* XXVI, 3, 1908.

> parts of the soma give out to the blood specific chemical substances which have a marked effect on development, and in presence of which the gametes develop. If we suppose that certain parts, *e. g.*, the frontal periosteum in the ancestors of deer, are stimulated to hypertrophy by external stimulation, this entails an increase in the hormone produced by this part of the body, and this hormone will affect the protoplasm of the gametes which obtain their nourishment from the blood. Mendelians and the majority of modern authorities on heredity and evolution assume that certain material parts of the gametes correspond and determine particular parts and characters of the soma, and therefore the hormones derived from these parts of the soma may well have an influence on the corresponding determinants in the gametes. . . . I must of course assume different hormones for different bones of the body, so that increased hormone from the frontal bone causes modification of the determinant corresponding to that bone, not of bone in general. Thus we have a material chain of influence from a particular part of the soma to the gamete, and from the latter to the corresponding part in the next generation. Whether this suggestion be true or not, it at least destroys the contention that we can not form a conception of the means by which a change in the soma can effect a corresponding part in the descendant. The hypothesis I have suggested would explain ordinary adaptations more easily than secondary sexual characters. It might be applied, for instance, to the hoofs, toes and legs of Ungulata. I hope soon to test my hypothesis by physiological experiment. If there is an influence from the parts of the soma to the determinants of gametes, then an ovary of one kind of animal grafted into another, ought to show an alteration in the character of the individuals developed from that ovary.

The author has apparently not seen an account of Guthrie's work of grafting ovaries. However, it is far from certain, or believable, that specific hormones are given off when the head is rubbed, which affect specific determinants in the germ which cause that specific part of the head to hypertrophy in the next generation in the special sex corresponding to the germ whose containing soma had its head rubbed. Doubtless there are those who would consider this to be complicated pangenesis worse complicated. There seems to be a further point consistently ignored by adherents to such a theory. They point out that only those animals have horns which fight by butting and believe that this proves that horns are developed by butting. They imply that if horses fought by butting they would develop horns; but it seems rather likely, on the other hand, that if horses had horns they would fight by butting. Cunningham, himself, quotes Rörig to the effect that stags with no antlers guard the females, not by butting, but by fighting with their fore feet. Likewise Henslow claims that similar structures in widely different plants in similar environments prove that these structures were directly produced by the environment. On the other hand, it can not be denied that some of these cases may be due to the similar selective action of similar environments.

Even Weismann was prepared to admit the inheritance of acquired characters in Protozoa, but Jennings[4] has thrown experimental doubt upon that also. In a second paper[5] he shows that the environment is, indeed, a large factor in determining the size of *Paramecium,* but, as yet, he has found no proof that these effects are inherited. Even selection seems powerless to affect the size within a "pure line." However, pure lines differing in size can easily be isolated by selection, thus confirming by a zoological example the results reached by several botanists, notably Johannsen. The variation curve of size is considered to be formed by a mixture of pure lines whose dimensions are modified by the environment and growth factors.

FRANK E. LUTZ.

EXPERIMENTAL ZOOLOGY

Hybridology and Gynandromorphism.—Raepke[1] has made a detailed examination of some of the hybrids (bastards) between certain species and varieties of Smerinthus (ocellata, populi and its variety Austanti). The material was obtained from the famous hybridologist Standfuss.

The anatomical results may be summed up as follows:

The internal genitalia of the normal male moths show much variation but in the hybrids the variations are more extreme; and often amount to "anomalies," and monstrosities, in the internal organs. Sperm elements are present and reach different stages of maturity, most of them degenerate later, producing a few imperfect spermatozoa. The female hybrids show also greatly modified sexual anomalies, both the germinal region as well as the ducts may be abnormal or even absent. Hand in

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[4] "Heredity, Variation and Evolution in Protozoa. I. The Fate of New Structural Characters in Paramecium, with Special Reference to the Question of the Inheritance of Acquired Characters in Protozoa." *Journ. Exp. Zool.,* 5, pp. 577–632, 1908.

[5] "Heredity, Variation and Evolution in Protozoa. II. Heredity and Variation of Size and Form in Paramecium, with Studies of Growth, Environmental Action and Selection." *Proc. American Phil. Soc.,* XLVII, 190, 1908.

[1] Raepke, W. *Jena. Zeitsch. f. Naturwissens.,* XLIV, 1908.